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Review of the genus *Paradoxecia* Hampson, 1919 (Lepidoptera, Sesiidae, Tinthiinae)

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Abstract. The clearwing moths of the genus *Paradoxecia* Hampson, 1919 are reviewed. Two new species, *P. vietnamica* sp. n., and *P. fukiensis* sp. n. are described from Vietnam and southeastern China, respectively. Redescriptions of *P. gravis* (Walker, [1865]) and *P. pieli* Lieu, 1935 are also provided. A key to all taxa currently known for the genus is compiled.

Key words. Sesiidae, Tinthiinae, *Paradoxecia*, new species, taxonomy, Vietnam, China.

The genus *Paradoxecia*, erected by Hampson (1919) for *Aegeria gravis* Walker, [1865], originated from “North China” [=eastern China, Shanghai?]. In 1935, K.O. Victoria Lieu described *P. pieli* after a series of specimens reared from larvae, boring in mulberry-tree twigs in eastern China. Until now, *Paradoxecia* contained only these two species. In 1933, Gaede placed *Paranthrene croconeura* Meyrick, 1926, a species from Sikkim, India, in *Paradoxecia*, as did Heppner & Duckworth (1981). However, we believe *croconeura* neither belongs to the genus *Paradoxecia*, nor even to the subfamily Tinthiinae. This species seems to belong to the genus *Adixoa* Hampson, [1893] or a closely related genus of the Paranthreninae. So, we remove *croconeura* from the genus *Paradoxecia*.

While investigating the Oriental Sesiidae from the collections of Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, Germany and Muséum d’Histoire Naturelle, Genève, Switzerland, we came across a few highly interesting specimens from Vietnam and southeastern China belonging to the genus *Paradoxecia* and distinct from the two known species of this genus. We describe the two unique species below. So, at present, the genus *Paradoxecia* includes four species, viz. *P. gravis* (Walker, [1865]), *P. pieli* Lieu, 1935, *P. vietnamica* sp. n., and *P. fukiensis* sp. n. In addition, we redescribe *P. gravis* and *P. pieli* and present a key to all known species of *Paradoxecia*.

Material examined or cited herein has been deposited in the following collections abbreviated in the text as follows: BMNH The Natural History Museum, London, Great Britain; ZFMK Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, Germany; MHNG Muséum d’Histoire Naturelle, Genève, Switzerland; MUT Zoological Laboratory, Faculty of Agriculture, Meijo University, Nagoya, Japan; CG collection of O. Gorbunov, Moscow, Russia.

Subfamily Tinthiinae, Tribe Tinthiini Le Cerf

Tinthiinae Le Cerf, 1917: 148. Type genus *Tinthia* Walker, [1865].**Genus *Paradoxecia* Hampson**

Paradoxecia Hampson, 1919: 51 (key), 114 (description). Type-species: *Aegeria gravis* Walker, [1865], by original designation. Dalla Torre & Strand 1925: 180; Gaede 1933: 797 (part.); Naumann 1971: 22, 55; Heppner & Duckworth 1981: 21 (part.); Fletcher & Nye 1982: 118.

Medium or large-sized clearwing moths with alar expanse 19–40 mm. Head with antenna filiform, shortly bipectinate and ciliate in male, without hair tuft apically; proboscis well-developed, long, functional; frons and vertex smooth, covered with elongate scales; labial palpus smooth-scaled. Legs with tibia and first tarsomere with short tufts of elongate, apically pointed and rusty coloured setae. Forewing entirely opaque, sometimes with a short and narrow semihyaline stripe in place of posterior transparent area; veins R4 and R5 separate, Cu2 short, stalked with Cul (Fig. 7). Hindwing transparent or densely covered with semihyaline with brownish or yellowish tinged scales; veins M1 and M2 nearly reduced basally; vein M2 arising slightly before cross-vein, M3 and Cul arising long before cross-vein; A1 well-developed (Fig. 7). Male genitalia (Fig. 10) with uncus well-developed, finger-shaped, covered with simple short setae, well separated from tegumen; tegumen triangular, broad, without gnathos; valva broad, rounded distally, covered with simple hairs and setae; saccus short and broad; aedeagus narrow, long, about twice as long as valva, with long coecum penis and with a strong thorn distally where penis broadens dorsally; vesica with numerous minute spinules. Female genitalia (Figs 8–9) with 8th tergite well-sclerotized, with numerous long setae at distal margin; papillae anales strongly sclerotized with outside curved ventral margin, or nearly membranous, with short setae; apophysis posterior somewhat shorter, equal or longer than apophysis anterior; latter sometimes with distinct ventral appendix; lamella postvaginalis sometimes sclerotized; ostium bursae membranous, on intersegmental membrane; antrum short, broad, slightly or well-sclerotized; ductus bursae short and broad, membranous; corpus bursae ovoid, membranous, without or with one or two signa.

Diagnosis. *Paradoxecia* seems to be closely related with *Tinthia*, *Microsphecia* Bartel, 1912 (distinct, not congeneric with *Tinthia*), *Paranthrenopsis* Le Cerf, 1911, and *Zenodoxus* Grote & Robinson, 1868. From all of these genera, *Paradoxecia* differs by the relatively larger size and by the short bipectinate antenna in the male (ciliate in these compared genera). In addition, *Paradoxecia* can be distinguished from *Tinthia* and *Microsphecia* by the shape of the aedeagus in the male genitalia (relatively short and broad with short cecum penis in these compared genera) and by the shape of the female genitalia (8th tergite and both pairs of apophyses relatively longer, antrum long in *Tinthia* and *Microsphecia*). *Paradoxecia* is distinguishable from *Zenodoxus* by the well-developed uncus and form of the distal part of the aedeagus (uncus small, aedeagus without thorn distally in *Zenodoxus*). This genus can be separated from *Paranthrenopsis* by the entirely opaque forewing (with small transparent areas in *Paranthrenopsis*) and by the shape of tegumen in the male genitalia (small, poorly developed in *Paranthrenopsis*). Additionally, *Paradoxecia* can easily be distinguished from the genus *Trichocerotha* Hampson, [1893] by the larger size, entirely opaque forewing and differences in both male and female genitalia.

Structure. The genus *Paradoxecia* currently consists of four species, viz. *P. gravis* (Walker, [1865]), *P. pieli* Lieu, 1935, *P. vietnamica* sp. n., and *P. fukiensis* sp. n.

Distribution. Known from the northeastern continental part of the Oriental Region: Vietnam, eastern and southeastern China. Including *P. gravis* in the Palaearctic sesiid fauna (Naumann 1971; Spatenka et al. 1993) is probably incorrect, because *P. gravis* is known only from "North China", which, in our opinion, is most likely Shanghai, a location somewhat south of the Palaearctic Region (Heppner 1991).

Key to species of *Paradoxecia* based on external characters

1. Abdomen dorsally only with yellow coloured stripes 2
- Abdomen dorsally without yellow coloured stripes or with yellow and dirty orange stripes 3
2. Alar expanse more than 35.0 mm; labial palpus white ventrally and light brown dorsally; abdomen ventrally entirely dark brown *gravis*
- Alar expanse less than 35.0 mm; labial palpus pale ochreous with a few brown scales both basally and apically; abdomen ventrally with narrow yellow stripes distally *pieli*
3. Abdominal tergite 4 with a narrow yellow stripe proximally; tergites 5 and 6 each with a narrow dirty orange stripe distally; ventrally sternite 4 with a broad yellow stripe proximally *fukiensis* sp. n.
- Abdominal tergite 4 with two small orange spots lateroanteriorly; ventrally abdomen entirely dark brown with violet sheen *vietnamica* sp. n.

Paradoxecia gravis (Walker) (Figs 1–2)

Aegeria gravis Walker, [1865]: 31. Type locality: "North China" [= eastern China, Shanghai?]. Holotype female (BMNH).

Hampson 1919: 114 (*Paradoxecia*); Dalla Torre & Strand 1925: 180 (*Paradoxecia*); Gaede 1933: 797 (*Paradoxecia*); Heppner & Duckworth 1981: 22 (*Paradoxecia*); Spatenka et al. 1993: 85 (*Paradoxecia*).

Redescription. Female (holotype) (Fig. 1). Alar expanse 39.5 mm; body length 17.3 mm; forewing 17.7 mm; antennae broken off.

Head: antennae broken off; frons rubbed out; labial palpus white ventrally and light brown dorsally; vertex dark brown; pericephalic hairs white.

Thorax: patagia dark brown; tegula dark brown to black with a narrow yellow inner margin; meso- and metathorax nearly without scales, dark brown; thorax laterally grey-brown.

Legs: fore coxa entirely dark brown; hind tibia dark brown with two tufts of rusty, longitudinal and apically pointed scales; inserting both medio-dorsally and apically; spurs dark brown.

Abdomen: dark brown; tergite 1 laterally yellow; tergites 2–5 each with a yellow, narrow, distal margin; ventrally entirely dark brown.

Forewing: entirely opaque, dark brown with violet sheen; cilia denuded.

Hindwing: transparent with brownish tinge; veins and outer margin dark brown; discal spot undeveloped; outer margin narrow, ca. twice as narrow as cilia; cilia dark brown.

Female genitalia. Not studied.

Male. Unknown.

Variability. Unknown.

Diagnosis. This species is closest to *P. pieli* Lieu and differs from it by the larger size (alar expanse up to 30.0 mm in *pieli*) and ventral coloration of the abdomen (sternites 1+2, 3, 4 and 5 each with a very narrow, yellow to pale yellow, distal margin in *pieli*). It can easily be distinguished from *P. vietnamica* sp. n. and *P. fukiensis* sp. n. by the coloration of the abdomen (tergite 4 with two small orange spots latero-anteriorly in *vietnamica* sp. n. and tergite 4 with a narrow yellow stripe proximally, tergites 5 and 6 each with a narrow dirty orange stripe distally in *fukiensis* sp. n.). These three species are also distinguishable from each other by the numerous details of the coloration of the body (see descriptions for *P. vietnamica* sp. n. and *P. fukiensis* sp. n.).

Bionomics and habitat. Unknown.

Distribution. Known only from the type locality: "North China" [eastern China, Shanghai?].

Material examined. 1 female (holotype), with labels as in Fig. 2 (BMNH).

Paradoxecia pieli Lieu (Fig. 3)

Paradoxecia pieli Lieu, 1935: 193, figs 1–39. Type locality: China, Hangchow [= eastern China, Zhejiang, Hangzhou]. Holotype male (probably lost, was kept in the author's collection, Musée Heude, Shanghai). Naumann 1971: 55, figs 18, 57, 172 (as *P. gravis*, misidentification); Hoppner & Duckworth 1981: 22.

Description. Female (Fig. 3). Alar expanse 30.0 mm; body length 15.0 mm; forewing 13.5 mm; antenna 5.2 mm.

Head: antenna dark brown with purplish violet sheen; frons brown; labial palpus pale ochreous with a few brown scales both basally and apically; vertex brown; pericephalic hairs dark yellow dorsally and white laterally.

Thorax: patagia brown with a large dark yellow spot lateroposteriorly; tegula brown with a few yellow scales apically; meso- and metathorax brown; thorax laterally brown with a small dark yellow spot at base of forewing.

Legs: fore coxa entirely brown to dark brown with violet sheen; hind tibia greyish-brown with violet sheen, internally slightly paler, with two tufts of rusty, longitudinal and apically pointed scales, inserting both medio-dorsally and apically; spurs greyish-brown.

Abdomen: brown with violet sheen; tergite 1 yellow laterally; tergites 2, 4 and 5 each with a narrow yellow margin distally; sternites 1+2, 3, 4 and 5 each with a very narrow, yellow to pale yellow, distal margin; anal tuft small, brown.

Forewing: entirely opaque, brown with violet sheen, basally somewhat darker; cilia brown with violet sheen.

Hindwing: densely covered with semitransparent scales with brownish hue, except on distal half where sparsely covered with brown scales; veins and outer margin brown; discal spot undeveloped; outer margin narrow, ca. twice as narrow as cilia; cilia brown with violet sheen.

Female genitalia (Naumann 1971: fig. 172). 8th tergite relatively short but broad, well-sclerotized, with numerous long setae at distal margin; papilla anales relatively small, slightly sclerotized, with numerous short setae; apophysis posterior somewhat longer than apophysis anterior; latter with distinct, long, ventral appendix; ostium bursae membranous; antrum short, broad, well-sclerotized; ductus bursae short and broad, membranous; corpus bursae ovoid, membranous, with an elongate signum.

Male. Somewhat smaller: alar expanse 19.6–22.5 mm; body length 10.6–13.0 mm (Lieu 1935).

Variability. Varies in individual size: alar expanse 19.6–30.0 mm; body length 10.6–15.0 mm. Sometimes abdominal tergite 3 with a narrow yellow margin distally.

Diagnosis. This species seems closest to *P. gravis* (Walker, [1865]) and differs from it by the individual size (alar expanse 39.5 mm in *gravis*) and coloration of the abdomen ventrally (entirely dark brown in *P. gravis*). It is possible that *P. pieli* is only a form of *gravis*. Unfortunately, only a single female (holotype) of *gravis* is known and its genitalia were not studied. From *P. vietnamica* sp. n. and *P. fukiensis* sp. n., *P. pieli* can easily be distinguished by the key given above. See also "Diagnosis" for comparisons of these species.

Bionomics (after Lieu 1935). The host plant is *Morus* sp. (mulberry) (Moraceae). The larva lives inside the thin twig, occasionally in a thick branch. Its development requires one year; the imago appears in July.

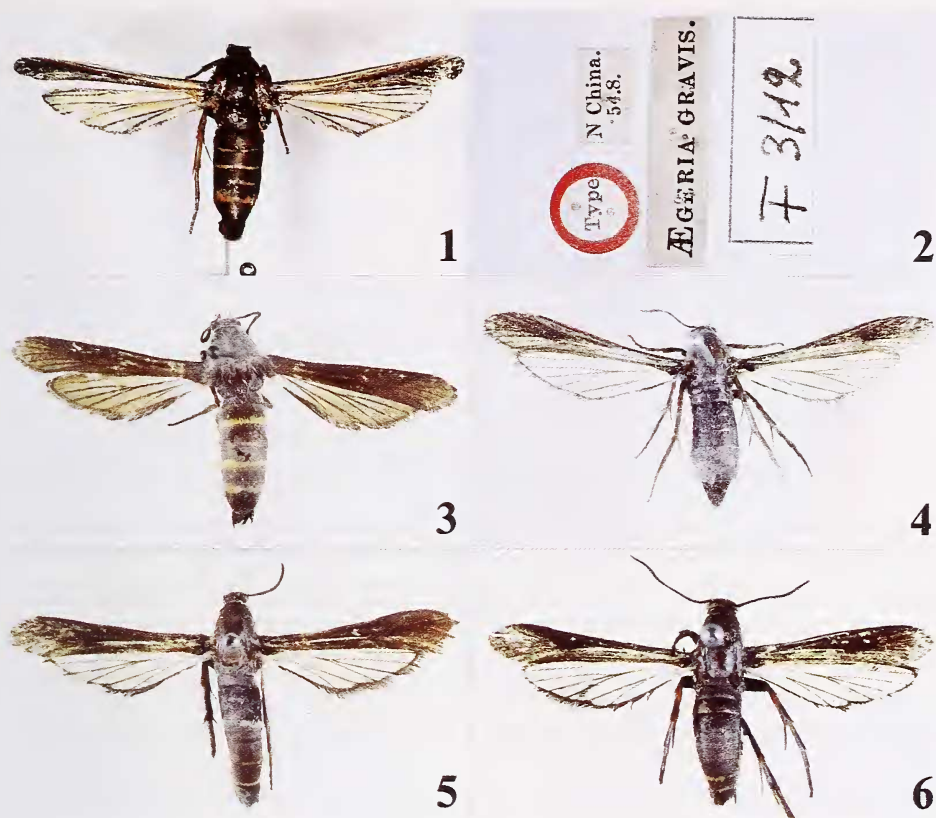
Habitat. Mulberry orchards.

Distribution. Known only from eastern China, prov. Zhejiang.

Material examined. 1 female, China, Hangchow [Hangzhou], 1. VII. 1934 (MUT).

Paradoxecia vietnamica sp. n. (Figs 4, 8)

Description. Female (holotype) (Fig. 4). Alar expanse 31.6 mm; body length 12.3 mm; forewing 15.5 mm; antenna 5.3 mm.



Figs 1—6: *Paradoxecia* spp. 1. *P. gravis* Walker, [1865], holotype, female (BMNH). Alar expanse 39.5 mm. 2. Ditto, labels. 3. *P. pieli* Lieu, 1935, female, China, Hangchow [Hangzhou], 1. VII. 1934 (MUT). Alar expanse 30.0 mm. 4. *P. vietnamica* sp. n., holotype, female (MHNG). Alar expanse 31.6 mm. 5. *P. fukiensis* sp. n., holotype, female (ZFMK). Alar expanse 28.0 mm. 6. Ditto, paratype, male (ZFMK). Alar expanse 24.2 mm.

Head: antenna dark brown to black with violet sheen; frons dark brown; labial palpus orange with a few pale yellow scales apically; vertex dark brown; pericephalic hairs yellow-orange dorsally and white laterally.

Thorax: patagia dark brown to black with bronze-violet sheen, with a small orange spot lateroanteriorly; tegula, meso- and metathorax dark brown with violet sheen; thorax laterally dark grey with violet sheen.

Legs: fore coxa dark brown with bronze-violet sheen, with a few orange scales basally; hind tibia dark brown with bronze-violet sheen, with two tufts of rusty, longitudinal and apically pointed scales; both inserting medio-dorsally and apically; spurs dark brown externally and white internally.

Abdomen: dorsally dark brown to black with violet sheen; tergite 4 with two small orange spots lateroanteriorly; ventrally entirely dark brown with violet sheen; anal tuft small, dark brown to black with violet sheen.

Forewing: black basally; costal margin dark brown with a narrow, longitudinal, light brown line; rest of surface covered with dark brown with violet sheen, with a few light brownish scales; transparent areas undeveloped, but covered with slightly lighter scales; cilia dark brown with bronzed sheen.

Hindwing: transparent with yellowish hue; veins and outer margin dark brown; discal spot undeveloped; outer margin about twice as narrow as cilia; cilia dark brown with bronzed sheen.

Female genitalia. (holotype, genital preparation No. GA-045) (Fig. 8). 8th tergite narrow, well-sclerotized, with numerous long setae at distal margin; papilla anales strongly sclerotized with curved outside ventral margin, with a few short setae; apophysis posterior somewhat shorter than apophysis anterior; latter without ventral appendix; ostium bursae membranous; antrum short, broad, slightly sclerotized; ductus bursae short and broad, membranous; corpus bursae ovoid, membranous, without signum.

Male. Unknown.

Variability. Unknown.

Diagnosis. This new species can be distinguished from *P. pieli* by the orange labial palpus (pale ochreous with a few brown scales in the species compared), coloration of the patagia (with a large dark yellow spot lateroposteriorly in *pieli*) and abdomen (tergites 2, 4 and 5, sometimes 3, each, with a narrow yellow strip distally in the species compared) and by the transparent hindwing (semitransparent with brownish hue, with distal half sparsely covered with brown scales in *pieli*). From *P. gravis*, *vietnamica* sp. n. differs by the smaller size (alar expanse 39.5 mm in *gravis*) and by the coloration of the abdomen and hindwing. The new species is easily distinguishable from *P. fukiensis* sp. n. by the coloration of the abdomen (tergite 4 with a narrow yellow strip proximally; tergites 5 and 6 each with a narrow dirty orange strip distally; laterally segment 1 yellow; ventrally sternite 4 with a broad yellow strip proximally in the species compared). Also, *P. vietnamica* sp. n. is clearly separated from *P. pieli* and *P. fukiensis* sp. n. by the female genitalia (compare fig. 9, and Naumann 1971: fig. 172).

Bionomics. The host plant is unknown. The moth has been netted near the end of May.

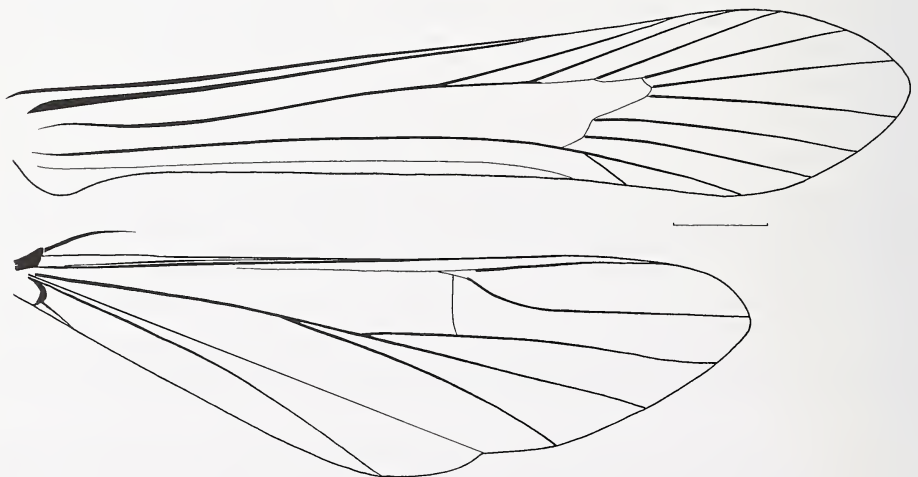
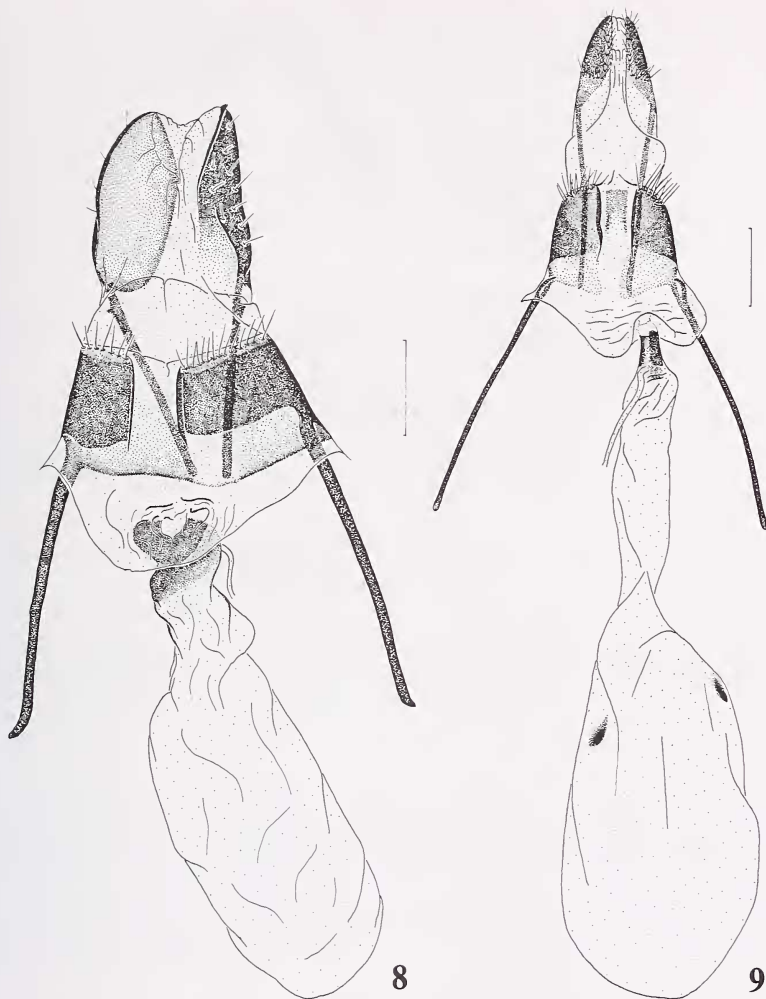


Fig. 7: Wing venation of *P. fukiensis* sp. n. Scale bar: 1.0 mm.



Figs 8—9: Female genitalia of *Paradoxecia* spp. 8. *P. vietnamica* sp. n., holotype (genital preparation No. GA—045). Scale bar: 0.5 mm. 9. *P. fukiensis* sp. n., paratype (genital preparation No. GA—075). Scale bar: 0.5 mm.

Habitat. Unknown.

Distribution. Known only from Vietnam.

Material examined. 1 female (holotype), Vietnam, Pahia, 24. V. 1950, J. Romieux leg. (MHNG).

Paradoxecia fukiensis sp. n. (Figs 5—6, 9—10)

Description. Female (holotype) (Fig. 9). Alar expanse 28.0 mm; body length 14.0 mm; forewing 13.0 mm; left antenna broken off, right one with broken tip.

Head: antenna dark brown to black with greenish sheen; frons dark brown with gold-green sheen, with a few dirty orange-yellow scales laterally; vertex dark brown with golden-green sheen; labial palpus pale yellow basally and dirty yellow distally; pericephalic hairs dirty yellow dorsally and pale yellow laterally.

Thorax: patagia dark brown with purple-green sheen, with a few dirty yellow scales latero-posteriorly; tegula dark brown with green-violet sheen, with a narrow dirty orange inner margin; meso-, metathorax and thorax laterally dark brown with green-violet sheen.

Legs: fore coxa dark brown with golden sheen, mixed with individual dirty orange scales; hind tibia dark brown with purple-violet sheen, with a few yellow-orange scales ventrally, with two tufts of rusty, longitudinal and apically pointed scales; both inserting medio-dorsally and apically; spurs dark brown.

Abdomen: segments 1-3 black with purple sheen, all other segments dark brown; dorsally tergite 4 with a narrow yellow stripe proximally; tergites 5 and 6 each with a narrow dirty orange stripe distally; laterally segment 1 yellow; ventrally sternite 4 with a broad yellow stripe proximally; anal tuft small, dark brown tipped with light brown.

Forewing: dark brown with bronzed sheen, mixed with individual light brown scales; costal margin narrowly dirty orange; anterior transparent area undeveloped; posterior transparent area very narrow and short, covered with semihyaline brownish scales with blue hue; external transparent area undeveloped, but scales between veins M3 and Cu1 somewhat lighter and with bluish hue; cilia dark brown.

Hindwing: transparent but densely covered with translucent scales with slightly brownish hue; veins dark brown mixed with a few dirty orange scales; outer margin dark brown, narrow, about twice as narrow as cilia; discal spot undeveloped; cilia dark brown.

Female genitalia. (paratype, genital preparation No. GA-075) (Fig. 9). 8th tergite relatively short and narrow, well-sclerotized, with numerous long setae at distal margin; papillae anales relatively small, slightly sclerotized, with numerous short setae; apophysis posterior somewhat shorter than apophysis anterior; latter with a short ventral appendix; ostium bursae membranous; antrum short, narrow, well-sclerotized; ductus bursae relatively long and broad, membranous; corpus bursae ovoid, membranous, with two oval signa.

Male. Generally less robust than female. Colour pattern as in female (Fig. 6).

Male genitalia. (paratype, genital preparation Nos GA-102 and 1570 YA) (Fig. 10). Uncus well-developed, finger-shaped, covered with simple short setae, well separated from tegumen; tegumen triangular, broad, without gnathos (Fig. 10a); valva broad, rounded distally, covered with simple short hairs and long setae (Fig. 10b); saccus short and broad, rounded basally (Fig. 10c); aedeagus narrow, long, about twice longer than valva, with long coecum penis and with a strong thorn distally where penis broadens dorsally; vesica with numerous minute spinules (Fig. 10d).

Variability. Vary only in individual size, not in coloration. Size varies as follows. Males: alar expanse 23.0-25.0 mm; body length 11.0-12.0 mm; forewing 10.5-11.5 mm; antenna 4.5-5.0 mm; females: alar expanse 22.5-32.0 mm; body length 10.5-15.0 mm; forewing 9.5-14.5; mm antenna 4.0-5.2 mm.

Diagnosis. By the coloration of the abdomen (bicoloured background coloration and bicoloured stripes) this species can not be confused with any other congeners. Additionally, by the shape of papilla anales and signum of the corpus bursae of the female genitalia, *fukienensis* sp. n. is clearly distinguishable from *pieli* and *vietnamica* sp. n.

Bionomics. The host plant is unknown. Imagines were collected during June at an altitude of about 2300 m.

Habitat. Unknown.

Distribution. Southeastern China, prov. Fujian. Known only from the type locality.

Material examined. Holotype female, China, Fukien, Kuantun, 2300 m, 27-40 N, 117-40 E, 13. VI. 1938, J. Klapperich leg. (ZFMK). Paratypes: 1 male, same locality as holotype, 8. VI. 1938, J. Klapperich leg. (ZFMK); 2 males, same locality as holotype, 26. VI. 1936,

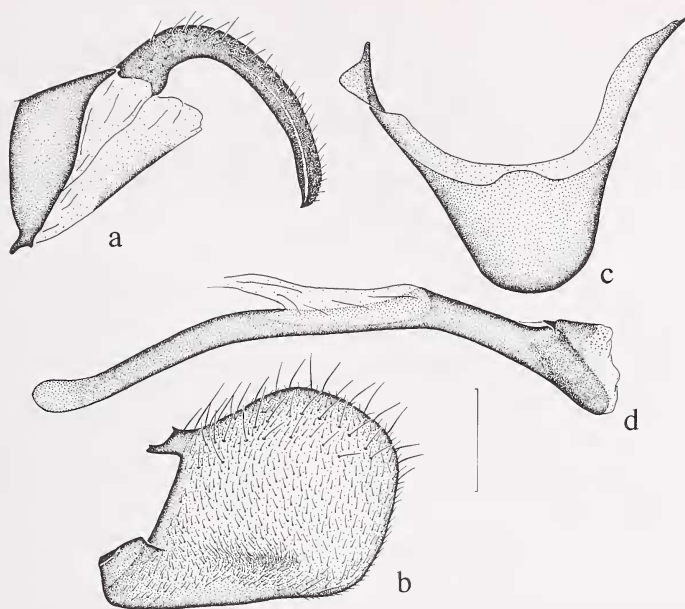


Fig. 10: Male genitalia of *P. fukiensis* sp. n., paratype (genital preparation Nos GA—102 and 1570 YA). a. Tegumen-uncus complex. b. Valva. c. Saccus. d. Aedeagus. Scale bar: 0.5 mm.

H. Höne leg. (ZFMK); 1 female, same locality as holotype, 8. VI. 1938, J. Klapperich leg. (CG); 1 female, same locality as holotype, 15. VI. 1938, J. Klapperich leg. (ZFMK); 1 male, 3 females, same locality as holotype, 16. VI. 1938, J. Klapperich leg. (male with genital preparation No. 1570 YA, GA—102) (MUT, ZFMK); 1 female, same locality as holotype, 25. VI. 1936, H. Höne leg. (genital preparation No. GA—075) (ZFMK); 1 female, same locality as holotype, 27. VI. 1936, H. Höne leg. (ZFMK); 1 female, same locality as holotype, 29. VI. 1938, H. Höne leg. (MUT).

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Zusammenfassung

Die Glasflügler der Gattung *Paradoxecia* Hampson, 1919 werden revidiert. Neben zwei neuen Arten aus Vietnam und SO-China werden die wenig bekannten Arten *P. gravis* (Walker, [1865]) und *P. pieli* Lieu, 1935 neu definiert. Ein Schlüssel erlaubt die Bestimmung aller heute bekannten Arten der Gattung.

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